EDUCATIONAL GAMES FOR STUDENTS WITH ADHD.
A real-word validated taxonomy of what to prioritize when designing educational games for ADHD- afflicted students.

Master Degree Project in Informatics
One year Level 22.5 ECTS
Spring term 2018

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Abstract

ADHD is a neurodevelopmental disorder that affects 5-7% of the global population of children, and the prevalence in western countries is reported to be even higher. This makes it the most common neurodevelopmental disorder in children. Traits often associated with ADHD are inattention, hyperactivity and impulsivity, all of which can impede a students’ education. There are instances where digital games have been used in the general education environment to increase focus and motivation in students, with positive results. Further examination of what problems are usually associated with an ADHD diagnosis can narrow the required design standards and allow for the development of Serious Games that specifically caters to the needs of children with ADHD. This paper aims to provide a glossary consisting of a rigid taxonomy of traits that are perceived as common in the ADHD diagnosis by multiple domains, to allow serious game developers a representative, short-hand introduction to the diagnosis. It will also include a tangible example of how the glossary can be used as a design basis in the development of a serious game aimed specifically at the education of ADHD-diagnosed students.

Keywords: Serious Games, Edutainment, Education, ADHD, Attention Deficit Disorder.
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1 Introduction

ADHD is a neurodevelopmental disorder with a significant occurrence in Swedish schools. The prevalence is estimated to be between 5-7% (Polanczyk et.al. 2007; duPaul & Ota, 2002), thus making it the most common neurodevelopmental disorder in children (AAP, 2011) which equals one to two students in every classroom. The traits commonly associated with the diagnosis has shown to have a negative impact on both academical performance (Sullivan-Carr, 2016) and general behaviour in afflicted students (Brick, 2017). There is a confirmed link between ADHD and low academical performance, and a lower quality of life as an adult (Bul et al. 2015). ADHD can also have a detrimental effect on the educational environment as a whole, and influence the neurotypical students in its vicinity (Furtick, 2010). The negative effects of ADHD are therefore not only limited to the afflicted and diagnosed student, but can also affect those who share an educational environment with that individual (Sullivan-Carr, 2016).

As common symptoms of ADHD include hyperactivity and impulsivity (Läkemedelsverket, 2009; AAP, 2011), the work environment of a teacher can be severely impaired by having an ADHD-diagnosed child in the classroom (Brick, 2017). To successfully mitigate the symptoms of ADHD would therefore be beneficial to the entire classroom situation, and a boon to the education of many children- ADHD and neurotypical alike. The educational system has an apparent need to take ADHD afflicted students into account when designing its curriculum (Nowacek & Mamlin, 2007).

The commonly occurring symptoms in ADHD-diagnosed individuals, hyperactivity, impulsivity and inattention are repeated throughout literature, and there seems to be no ambiguity on how these traits affect an individuals’ personality and academic performance. One of the most common interventions to ADHD is by medicating afflicted individuals with psychostimulants (DuPaul & Ota, 2002; Roh & Lee, 2014, Schultz & Evans, 2015). The effect of the medication is often not long term and needs to be continuously supplied to the afflicted individual for results, and there are reports of varying side effects (Roh & Lee, 2014). According to Roh & Lee (2014) and Nowacek & Mamlin (2007) there is currently no evident universal way to mitigate these symptoms in the school environment that does not rely on medication, and the decision of how to manage the situation is usually left to the individual responsible teachers.

One suggested adjustment to the general educational situation in favour of these students, is to implement serious games in the classroom environment. In the context of education, the focal point of a serious game is the engaging mechanics commonly found in leisure games. By harnessing some of those engaging traits and applying them to an educational situation, there is good evidence that the serious games approach can be an effective tool in motivating and engaging a student (Giunti et.al, 2015; Bul et al., 2015). Games have the potential to tap into the motivation that can naturally occur in the individual, and it is a method not depending on psychostimulant drugs or biochemically altering medications to increase engagement. While the mind is in an engaged state, the individual is spontaneously attentive. When experiencing a flow in an activity, the surrounding world often cannot compete with the task at hand, and a state of immersion emerges. If this level of engagement could be achieved in a classroom environment it could have a measurable impact on knowledge retention compared to traditional teaching methods. A successful motivational tool would benefit the entirety of the
If it is possible to diminish or mitigate the symptoms of ADHD with a serious games approach, it can be a preferable treatment to medication in the educational environment.

The unambiguous consensus of ADHD can serve as a solid foundation when designing a serious game targeted at that demographic. To further define and narrow the focus for any eventual design, this paper examines the descriptive language used to define ADHD in multiple domains; literature in the fields of pedagogy and serious games, specialist and clinical literature, as well as in the common discourse of teachers and educators. The language identified in these domains was then validated by a sample of special pedagogues and assigned a value on an agreeability index. The validated terms were summarized in a glossary with the intent of serving as a design basis when developing a serious game targeted at ADHD-afflicted students. The final glossary contains a total of 35 multi-domanial descriptions about ADHD, that are listed with their individual score on the agreeability index.
2 Background

A serious game is the name given to an artefact with designs based in traditional entertainment game design, but with an ulterior motive beyond mere entertainment. The approach of Serious Games can be applied any context where a boost in motivation, engagement and immersion will have a favourable effect on the desired outcome. Those fields can include education, training, rehabilitation, marketing, etc. There have been reports of success using serious games in the training of military personnel or firefighters (Rugelj, 2015) as well as in the training of medical staff (Petit Dit Dariel et al., 2013) to provide an environment where mistakes won’t result in fatality. Using games as a means for education under the term serious games has been practiced since the 1970s’ (Vogel, 1970), and applying game-like methods to education has shown promise in increasing student engagement and motivation (Ruglej, 2015; Bul et al., 2015; Ota & duPaul, 2002) and it has proven beneficial to children’s concentration to use digital games, rather than physical ones (Papanastasiou, Drigas, Skianis, Lytras, 2017).

Some of the most prominent symptoms of ADHD linked to low academic performance can be argued to be mitigatable by the positive effects of a serious games approach. As a well-designed game demands focus on the players’ behalf, attentivity naturally increases. And a stern focus on a task inhibits any excess or extrovert activity, thus having the possibility to avert the hyperactivity trait. It is not without reason that authors and researchers express a positive and optimistic perspective when presenting the introduction of serious games in ADHD education. Roh & Lee (2014) examines evaluative criteria for diagnosing ADHD, and argue their motivations and their positive stance on ADHD and educational games;

“Games have a positive effect on the attention improvement of ADHD children because they promote voluntary participation and motivation and require a high level of continuous interest, concentration, endurance, and cognitive ability that needs logical thinking or strategies for problem solving” (Roh & Lee, 2014, p.2486).

Continuing the positive outlook, Bul et al. (2015) designed a serious game whose target audience is youths with ADHD with the aim to exercise some of the skills usually lacking in the diagnosed individuals. One argument on behalf of their selected media is referring to an increase in concentration;

“[…] children with attention deficit/ hyperactivity disorder (ADHD) tend to have fewer problems with concentration and engagement when playing digital games […]” (Bul et al. 2015, p.502)

Through conjectures and statements like these, a promising and hopeful perspective began to emerge in combining ADHD education with a serious games approach.

2.1 ADHD- Summary of prominent symptoms.

Recurring in many instances of medical literature assessments for ADHD are three diagnosis criteria; inattention, impulsivity and hyperactivity (Läkemedelsverket, 2009; NCCMH, 2009). These three terms describing ADHD-afflicted individuals where repeated in every piece of relevant literature, rarely even varied with a synonym or different conjugation. By accepting
these three traits as common consensus, focus can be shifted to the exploration of how they affect the everyday life situations of afflicted individuals.

**Inattention.**
As a general rule, the inability to be attentive will arguably result in a lower retention rate. This is especially relevant in an educational environment, where instructions are given on a regular basis, with the expectation of using those instructions to complete a following task. This might be the key trait to why ADHD is associated with significant academic difficulties (Nowacek & Mamlin, 2007). It is an inability to internalize instructions or knowledge, and therefore also an inability to follow instructions and accumulate knowledge. That is a key part of academic studies, and will greatly impact and affect the outcome of an ADHD-afflicted individuals’ education (NCCMH, 2009).

**Impulsivity.**
The inability to inhibit impulsive behaviours, such as blurting out communications prematurely, or resorting to an action without consideration for potential consequences can be detrimental to an environment that is dependent on a calm and quiet milieu. The Stroop test (Stroop, 1935) contains a sequence of challenges which are easy to comprehend, yet hard to execute. The subject of the test is presented with one of many flash cards, which has the name of a colour written on it. The font of the colour’s name is itself printed in a colour, unrelated to the colour it spells out. For example; a card can have the word “RED” printed on it, with the lettering being printed in a blue colour. The goal of the test is to say out loud the colour of the print, and inhibit the reflex to just read the letters on the flash card. Thus, an individuals’ ability to inhibit their reflexive response is tested. The idea is that a person with prominent impulsivity traits, that are common within the ADHD-diagnosis, would have greater difficulty with this inhibition, and more often blurt out the instinctual answer. Transcribing this situation to a classroom environment, not being able to restrain yourself from blurting out a premature answer can be categorized as disruptive behaviour, and be detrimental the classroom environment.

**Hyperactivity.**
The general education classroom usually consists of one educator communicating to some 20 students. This paradigm demands that the receiving end of the communication should be silent enough to be able to hear the communication. Hyperactivity impedes the ability to sit still and be quiet, and compels the afflicted student to walk around or run about. Some specially adapted educational environments can function despite these behaviours, but in the general education classroom, it usually servers as a distraction for the other students (Brick, 2016), and can have negative impact on the overall work environment of the educator. This trait affects the academic situation not only the afflicted, but also the neurotypical students with whom they share an educational environment.

According to Schultz & Evans (2015) these three prominent traits can occur in different variations and combinations and are thusly divided up into three sub-groups, or presentation specifiers. An individual who struggles predominantly with inattention and a short attention span belong in the specifier ADHD-PI, while a person whose most prominent deviations are hyperactivity and impulsivity belong to the specifier ADHD-HI. Should these two categories be equally prominent, the type is combined and belongs in the specifier ADHD-C.
2.1.1 Potential benefits of mitigating ADHD symptoms.

In a study stretching 30 years and including 1000 individuals, Moffitt et al. (2010) showed a link between childhood level of self-control and adult-life variables of financial income and physical and mental health. Low self-control can be linked to health behaviours such as overeating, smoking, drinking, drunk-driving and numerous psychiatric disorders, as well as unemployment and criminal behaviours (Moffitt et al, 2010, p.2693; NCCMH, 2009, p.37). There appears to be both environmental and genetical influences responsible for our behaviour in the context of self-control. In any way it then can be mitigated by environmental factors, it is in the best interest of a society to ensure a pedagogical environment that fosters self-control. Thus, having a low degree of self-control, and therefore also a high degree of impulsive behaviours commonly found in ADHD, affects the individual in a negative way.

There is a well-documented link between ADHD and low academic performance, as an estimated 75% of ADHD-affected students exhibit difficulties in their education (Schultz & Evans, 2015; NCCMH, 2009). Diamond & Lee (2011) highlights executive function (EF) as a relevant way to measure a child’s likelihood for academic success, even more so than the commonly canonical intelligence quotient, IQ. EF includes such traits as self-control, persistence and discipline; traits usually lacking in children with ADHD. Children lacking in these EF-traits are reportedly worse off in terms of health, and more likely to have an adult life with lower income, and even a higher risk of being involved in criminal activity (Diamond & Lee, 2011, p.959). These observations can serve as examples on the benefits of accommodating ADHD-students into a good education.

2.2 Serious games in education.

There is an optimistic perspective on using games as an educational tool, but despite the long active period and positive trends, there is still no standardized way of implementing games in the classroom (Kangas, Koskinen & Krokkors, 2017). What type of game to use, in what frequency and during how long is all left to the individual educator to decide, without any official frame of reference to rely upon. It is not yet a widely recognized approach, despite the expectations of an increased motivation to learn and in the time spent partaking in study material that is suggested by the promoting studies and literature.

To contrast the optimism of digital games as an educational holy grail, there are sceptical concerns being presented. A notion of the current generation of students being digital natives, who instinctually adapt to and traverse digital interfaces, is under scrutiny. Evident in the results of a study by Berg-Marklund (2015) there are still obstacles for students to overcome before accessing the engagement promised by the advocates of digital games in education. Egenfeldt-Nielsen (2004) reports difficulties with both hardware and students’ interaction with the software in his study, where a commercial game was used as a feature in history subject education.

“[…] despite a month-long preparation, where the computer games had been installed and tested. For the first weeks the first 15 minutes were tied up with login problems, bad CD ROM drives, incorrect wired computers, video driver problems, and other technical issues.”

(Egenfeldt-Nielsen, 2004, p.19)
The educational games available today come in a broad spectrum of aesthetics and pedagogical theories. Here follow two examples to illustrate some of the many different shapes that serious games in education and special education can take on. The educational game Math Blaster, published by Davidson & Associates in 1983, is one of the earliest examples of computer games being used in the school environment, and illustrates the beginnings of this part of the didactical discipline. The later example, Kakmakeriet, developed by Zcooly AB in 2017, is a more recent attempt at an educational math game, released contemporary to this paper, and is included to illustrate the rate of progression and development in the field, as the two examples are separated by 34 years.

2.2.1 Example: Math Blaster.
In the 1983 game Math Blaster, a narrative is constructed around solving simple mathematical tasks. The player is presented with narrative context such as “An evil alien kidnapped your friend Spot”, and then instructed to gather fuel as to execute the rescue mission. The way of gathering fuel is of course to solve simple equations.

![Figure 1 - Screen shot from Math Blaster.](image)

The mundane and repetitive task of solving a number of similar math problems is here given an extra dimension as to motivate the student. Ota & duPaul (2002) showed an increase in active engaged time of students who played Math Blaster.

2.2.2 Example: Kakmakeriet
In the 2017 game Kakmakeriet (the Cake-factory), children get to learn about geometry, division and fractions by operating a bakery. The math is applied in mixing ingredients, decorating and cutting up cakes into pieces, as it could be used to achieve the same goal in real life.
Here, the math is presented in a milieu where it’s presence is inherent, and the fulfilment of the tasks are motivated by a narrative where the students operates a bakery. There is currently no published research concerning the success of using Kakmakeriet as an educational tool.

2.3 Serious games in special education.

There have been reported instances where teachers admit to feeling pressured to maintain the same orderly and academic standard for students with ADHD as with neurotypical students (Brick, 2016). And though there is an evident concern on the need for a modified curriculum to accommodate ADHD-students (Sullivan-Carr, 2016; Nowacek & Mamlin, 2007), there are few opportunities for general education teachers to get the training required to properly accommodate a student with diagnosed ADHD (Brick, 2016).

ADHD is not the only neurodevelopmental disorder that is examined in the context of serious games. Whyte, Smyth & Scherf (2014) argue that Autism Spectrum Disorder (ASD) also can be aided by the use of serious games, or computerized interventions. Their arguments are based on research on how serious games have been used to promote skill acquisition and encourage behaviour changes in regard to health, as well as some studies where ASD-individuals were subjected to serious games to promote behavioural changes. One cited study is an instance of facial recognition training, where children with ASD showed an improvement in facial recognition after a six-week period of utilizing a program called FaceSay, as compared to a control group. The optimism that is expressed about ADHD & serious games has a noted presence in the ASD-education field as well.

Students with ADHD can benefit from many curricular adaptations, including a serious game-approach and computer-assisted instructions (CAI) (Sullivan-Carr, 2016; DuPaul & Ota, 2002). These two fields can of course often overlap, as it is common for educational games to be played on computers or similar devices. While playing digital games, students with ADHD display less difficulties with concentration and engagement (Bul et al., 2015; Papanastasiou, Drigas, Skianis, Lytras, 2017), which are two common problem areas for diagnosed students.

**Figure 2** - Mixing ingredients for a cake in Kakmakeriet.
that often impede their academic performance. Here follow two examples of serious games developed in the contexts of ADHD. Both games, Algebra Champ and Plan-it Commander, have been evaluated in peer reviewed material.

2.3.1 Example: Algebra Champ
Sullivan-Carr (2016) conducted a study where students with ADHD participated in math lessons to learn algebra via the digital game *Algebra Champ*. The game is presented as an app, executable by a smartphone or tablet device. In *Algebra Champ*, the player chooses a fighter, a small avatar to accompany them during a barrage of algebraic equations (see figure 1), while a timer ticks away to measure the time it takes to solve the equations necessary to complete a difficulty level. It is a simple digital tool that relies on only a click-or-tap interaction.

![Figure 3](image.png)

*Figure 3*  - Screen shot of Algebra Champ- level 1.

The inclusion on these crudely draw fighters despite there being no narrative nor mechanical fighting in the game attempts to give the math problems a context. The ticking timer gives the player a sense of how well they are performing, but to include the visible ticking so close to the focal point of the screen could be almost directly detrimental to engage children with attention problems. The improvement rate on the admittedly small sample of participants was overall positive, as reposted in Sullivan-Carrs’ (2016) article. The user satisfaction of Algebra Champ was noted to be higher that the use of standardized educational materials. The students participating in this study noted the teacher as being “cool” for applying the use of a serious game (Sullivan-Carr, 2016, p.66).

2.3.2 Example: Plan-it Commander
Taking on the symptoms of ADHD outside the classroom and curriculum, the serious game Plan-it Commander turn its attention towards how the traits commonly found in ADHD-diagnosed individuals affect their personal life. The academic field is only one of the aspects of life which can be impeded by ADHD-symptoms. In the game, the player takes on the role of a space captain in a futuristic adventure, similar to the narrative context of *Math Blaster*. Navigating through space in search on minerals, the player completes missions and tasks
designed to improve some of the personality traits ADHD children often struggle with, such as time management, organizational skills, and prosocial skills.

Figure 4 - A space hub in Plan-it Commander.

The game has different modes with different foci in the form of missions, side missions and mini-games, which leads to a diverse and varied game experience. There is also an interface to communicate with other players via predefined messages, to address the social difficulties often reported as a consequence of ADHD. Bul et al. (2015) reports that 67% of children who played the game during a testing session claimed to have learned while playing.

2.4 Background summary

The application of serious games in education is presented with enthusiasm in the background literature, and likewise in the context of special education focused on ADHD. The examples showcasing serious games for use in special education often feature reports of increases in academic performance. While acknowledging the criticism of the enthusiastic expectations that draws focus to the problems that can occur with gamifying the education, the over-all consensus is presented with enthusiasm.
3 Problem

The notion of using serious games in the education of ADHD-afflicted students is presented both with an optimistic perspective and positive trial results. Serious games have been shown to increase motivation and focus, which are usually scarce in ADHD-diagnosed students. The notion that digital games used as an educational supplement can have a positive outcome on the academic performance and attentivity of children with ADHD was at least partially confirmed in a 2002 study by DuPaul & Ota, where they tested the educational game Math Blaster in a general education setting. The conclusion of their study implies that the digital tool with game-like elements increased focus and attention in all participants with ADHD (DuPaul & Ota, 2002). Some improvement in math skill was also evident in all participants. With the high prevalence of ADHD in mind, and the promise that serious games show in the target group, there is good reason to continue the development and adaptation. Therefore, the research question this paper aims to answer is;

What problems could be significant for developers to keep in mind when designing educational games specifically for ADHD-students?

To present an answer to this question, this paper suggests a glossary of commonly occurring formulations of problem-areas within the ADHD diagnosed individuals. This glossary will be containing descriptive terms and phrases about the traits associated with ADHD, and will ideally be suitable for serious game developers to get a valid overview of what problems and difficulties that might be present in the educational context specific to students with ADHD. The descriptive terms and phrases will be synthesized from the discourse and perspectives of different domains; peer reviewed material, clinical literature and the real-world situation as described by teachers and teacher’s assistants working with ADHD-students.

3.1 Method

The main study consisted of two data gathering methods; a literature review, and interviews with professional educators. The literature review was conducted on peer reviewed material about ADHD in the context of serious games or education and included specialist literature about ADHD from a clinical perspective. The literature was gathered by searching the collective data bases employed by the University of Skövde and the University of Gothenburg, and the search phrases included the terms: ADHD, Attention deficit disorder, Attention deficit hyperactivity disorder, Educational games, Serious Games, & Video Games, in various combinations. The abstracts of the resulting papers were reviewed and scoured for descriptive terms and phrases, both in context of symptom description and in the context of video games usage as a method of education or rehabilitative therapy. The literature was qualitatively examined for descriptive terms or phrases about the diagnosis, and those descriptions were collected in a separate document. The second part of the data was gathered via eight interviews conducted with different educational professionals, who all professed to interact with students with ADHD between the ages of 8 and 12 on a regular or daily basis. The interview respondents are all currently employed by a Swedish school as a classroom teacher, subject teacher or teachers’ assistant. The interviews were conducted in a semi-structured fashion, where the interviewer had prepared questions as a framing device for the interview, but asked the
respondents to talk as freely as possible to ensure an uncensored representation of their experience. These interviews were transcribed, and the transcriptions were qualitatively examined for descriptive terms or phrases.

The process of isolating representative terms was to be conducted with rigor to compensate for the lack of previous academic knowledge of ADHD represented in the authorship of this paper. Therefore, any term that is claimed to hold merit here had to meet the predetermined criteria. To qualify as a legitimate and representative term or phrase, the term or phrase must meet at least one of the following criteria:

- Be mentioned in peer reviewed articles (in the context of pedagogy or serious games).
- Be mentioned in specialist literature.
- Be mentioned by professional educators during a semi-structured interview.

If these criteria were met, the descriptive terms were summarized in a glossary. The glossary was then transcribed into a survey format, where each description was presented as a statement to be ranked on accordance, according to how much the respondents personally agreed with the statement as representative of ADHD-traits. When the surveys were returned, the statements were arranged in accordance with how high they ranked on the agreeability index. The finished glossary contains descriptive terms and phrases found in peer reviewed and specialist literature, as well as in the common discourse of professional educators and teachers’ assistants, and will be argued to qualify to serve as a design basis in the eventual development of an educational tool specially adapted to children with ADHD.

Figure 5 - Illustration of method procedure.
3.1.1 Literature search method

To gather representative sources for the synthesized terminology, the method of a literature overview search was utilized. This method in literature review is suitable for summarizing an established background and to get a lucid view of a consensus (Eriksson-Barajas, Forsberg & Wengström, 2013). The process of searching for relevant literature was conducted via two search engines available at two Swedish universities; the university of Skövde and the university of Gothenburg. The two search engines, Supersök and World Cat Discovery respectively, include a large number of different databases. These search engines were selected to obtain literature in the discipline of digital games, as well as the discipline on pedagogy. The same words were used while searching both engines, but with a higher expected outcome of literature regarding video games from the World Cat Discovery engine, and a higher expected outcome of literature regarding pedagogy from the Supersök engine. The included search words were ADHD, Attention deficit disorder, Attention deficit hyperactivity disorder, Educational games, Serious Games, & Video Games. The first 30 results of results that included peer reviewed literature was inspected, and the abstract read. Even with this straightforward search method, the searches yielded a fairly low percentage of relevant literature. A search for the phrases “ADHD serious Games” on the World Cat Discovery search engine leads to a result page where ADHD is not part of any title or description until the 7th result. This lead to multiple iterations of searches with many variations of the search phrases. The literature that did turn out to be relevant was easy to distinguish; if ADHD or any description thereof was prominent in the abstract, the literature was read in its entirety. Any descriptive terms or phrases were noted in a document, with its source marked down. The literature that qualified to being part of the taxonomy was assessed in a quantitative manner, rather than qualitative; the more the literature referred to and described ADHD and its traits, the more relevant it was deemed. As this search method only included peer reviewed material or specialist literature, the quality of the terms was assumed to be satisfactory, and therefore the quantity of terms was prioritized. This method yielded ten articles to contribute their descriptive language. See detailed results and content in chapter 4.1 Result of literature review.

3.1.2 Interview Procedure

The interviews were conducted in a semi-structured fashion with eight professional educators currently employed in a Swedish school, who all reported to have experience working with children with ADHD. A semi-structured interview utilizes a pre-determined questionnaire as basis for the interview, but treats the questions more like themes for a discussion, thus giving the respondent the freedom to formulate the answers in their own preferred way (Bryman, 2011). The interview included open-ended questions and invitations to descriptions. The interview questions were:

- Can you describe what traits and mannerisms you perceive in students with ADHD?
- Can you describe how those traits affect the academic performance of those students?
- Can you describe how those traits affect the classroom environment?
- Are there any traits that you perceive as universal to ADHD students?
- What methods do you use to cope with, or mitigate, these traits?
- Have you tried any additional tools or resources in the education of these students?
The interview respondents were selected due to social proximity, and share a preexisting professional relationship to the author of this paper. The interviews were structured to be similar to an inquisitive conversation with the end goal of getting an organic conversation to represent a common discourse within the profession. The Swedish school system employs teachers who have all gone through the same academic channel to earn their degree, and even though the sample group is limited to one specific geographical location, the respondents should have the same knowledge base as the general population on teachers. Other than educated teachers, the sample group was comprised of teachers’ assistants, whose professional role include tending to children with special needs in the classroom. The student personnel in this study all had experience in working specifically with ADHD.

As the interviews were meant to be semi-structured, the respondents were instructed to answer as freely as possible and encouraged to elaborate their thoughts. See detailed results and content in chapter 4.2 Summary of interviews, and see interview transcripts in appendix A.

3.1.3 Survey procedure.
To further ensure that the 37 terms and phrases identified in the literature review and interviews were indeed valid and representative, a survey containing 36 of the 37 terms were sent out, with an instruction to rank them in relation to how well the individual terms represented the respondents personal experience of ADHD. One term was omitted from the survey, as the trait “sleep disturbances” takes place outside the teachers jurisdiction, and would best be answered by parents or caretakers. Compared to the interview method, the survey method runs the risk of miscommunication, as the conductor of the survey is not present during the respondents’ answers. It is therefore important that the surveys are formulated in an understandable way, to avoid confusion and to let the respondents understand what they are answering (Bryman, 2011). The respondent group that received an invitation to answer the survey were selected on a basis of expertise, and comprised solely of special pedagogues. The entirety of the special pedagogues working in Swedish elementary schools in one of the largest municipalities in Sweden, who had their contact information listed on their respective schools’ web page containing an e-mail address were contacted. A total of 55 e-mails were sent out along with a short introduction letter that explained the nature of the survey, as suggested by Alan Bryman (2011) in his book on social science methods Samhällsvetenskapliga Metoder. The ranking of each term was on a 6-grade Likert scale, to get quantifiable data, and to avoid a neutral answer as there is no midway between the integers 1 and 6.

A pilot study of the survey method was conducted to ensure both that the terms and phrases was presented in an understandable manner with a language the respondents could understand, and also to test the data-gathering function of the surveys, which were sent out digitally by email. The pilot survey contained the same terms to be ranked as the final survey, but had one additional question at the end, where the respondents were asked to describe if the survey had been clear and understandable. No elements of confusion were reported, so the survey was sent out to the final target respondent group. See final results in chapter 4.3.
3.2 Method summary

To examine and present an overview of the traits associated with ADHD, a list of occurring descriptions found in literature and in the discourse of practicing educators was created. That list later went through a validation process via surveys sent to special pedagogues, where the individual descriptions were ranked in agreeability. The final glossary containing these descriptions is intended to be used as a short-hand introduction to ADHD for serious game developers to get an overview of the commonly occurring traits of the diagnosis.
4 Identifying descriptive discourse

The resulting data consisting of descriptions of ADHD-students from these two domains were merged into the first iteration of the glossary, the synthesized terminology (see figure 5). Once the terminology was summarized it was put through a validation process via a survey, where special pedagogues ranked each description in terms of how well it reflected their view of the diagnosis. The final glossary then includes a rank-order wordlist of how the diagnosis is viewed in the domains of both academia and practise.

4.1 Result of literature review

The literature comprised of peer reviewed articles about ADHD in the domains of serious games and education, and specialist and medical literature about the diagnosis. The articles contained evaluative assessments of the development of two serious games for ADHD-students, that had been developed to mitigate some of the academic or social difficulties associated with the diagnosis. Bul et al. (2015) document their process and user satisfaction in the development of the ADHD-focused serious game Plan-it Commander (see chapter 2.3.2), and Wronska, Garcia-Zapirain & Mendez-Zorilla (2015) presents the development of an i-pad based educational tool for children and adolescence with ADHD. Sullivan-Carr (2016) conducts a study with the math game Algebra Champ (see chapter 2.3.1). These three papers have a concrete focus on tangible serious games, whose examples on focus areas, design solutions and criteria gave an insight to possible serious game design methods. DuPaul & Ota (2002), Schultz & Evans (2015) and Furtick (2010) discuss learning and school environments, and possible interventions to increase the academic performance of ADHD-students. Nowacek & Mamlin (2007) examines the possible modifications to be made to the school curriculum to better accommodate ADHD-students, and provides an insight into teachers’ knowledge and experience of ADHD. Roh & Lee (2014) looks at ADHD diagnosis criteria from a serious games perspective, focusing on how to measure attention while interacting with CAI. This literature in the domains of serious games and pedagogy (often overlapping) were complemented with literature with a more clinical approach, from the Swedish Medical Product Agency Läkemedelsverket (2009) and the British National Centre for Mental Health (2009), who provided a medical perspective on the diagnosis. A total of ten articles and papers was included in the terminological literature review, and the discourse used in this literature when describing ADHD and its traits was summarized as part of the synthesized terminology (see figure 5).

The literature review suggested that there was no apparent ambiguity in the way ADHD is defined, between educators, pedagogical researchers, medical authority, and administrative authority. Early in the process of reviewing literature, a common set of terms became apparent. Among those most recurring words and phrases were the descriptive terms inattention, hyperactivity and impulsivity, which were repeated in the majority of literature independent of discipline. From government issued medical information literature (Läkemedelsverket, 2009) to pedagogical specialist literature (NCCMH, 2009), to peer reviewed evaluations of serious games (Bul et al., 2015; Wronska, Garcia-Zapirain & Mendez-Zorilla, 2015), all share the same perspective and discourse on the way ADHD manifests in an individual.
The fact that the common discourse is widely used across separate academic fields suggests a well-defined problem area. This is substantiated in an article examining the teachers’ perspective on ADHD, conducted by Nowacek & Mamlin (2007), where it was concluded that a majority of teachers generally have a good understanding of ADHD and its characteristics, as well as how those traits affect the educational situation of afflicted students. But there was also an evident scarcity of knowledge regarding standardized educational methods and approaches for how to adapt the curriculum and tutoring when educating ADHD students (Nowacek & Mamlin, 2007; Brick, 2017). Some literature highlighted the notion of increased success when applying computer assisted instructions (CAI) in the education of ADHD-students (Sullivan-Carr, 2016), a claim that was echoed in the later interviews.

The unison of discourse across multiple academic fields implies an accepted consensus, that from a design perspective defines and limits the problem areas for which design solutions might be needed. The descriptive terms and phrases identified in the literature review were summarized in the first iteration of a glossary. For final glossary, see chapter 5.

4.2 Result of interviews

The interviews were conducted with eight professional educators who were all currently employed in the Swedish school system and working in the same elementary school in a municipality in the vicinity of Gothenburg. The respondents included classroom teachers, subject teachers and students’ assistance.

Many of the interview questions who inquired about general traits homogenous to the diagnosis were answered with statements about how each child is unique and that each individual is different. Interview respondent 3 states “They are all different, very hard to be specific. Different diagnosis. No child is the other alike”. And interview respondent 5 contributes “Some are of course very outwards, and aggressive. But not everyone, some are very quiet.”, to illustrate the wide difference that can be perceived within the same diagnosis. Other respondents reply with more tangible examples of traits they experience as generally prominent including difficulties in social situations (respondent 6) and difficulties being still (respondent 7). Many respondents presented a noticeable effect on the classroom environment when the group included one or more students with an ADHD diagnosis. Interview respondent 3 states that the effect on the classroom environment is the biggest influence of ADHD. Interview respondent 5 responds similarly with “It affects us”. Interview respondent 6 contributes a perspective, “It’s not always a negative impact, I believe.”, again illustrating the fact that the diagnosed children are individuals, and not a completely homogenous group.

The interview situation opened up the possibility to inquire about the methods and practices that the respondents apply to managing and mitigating some of the problems that can arise with an ADHD students’ education. Interview respondent 1 supports the claims presented by Sullivan-Carr (2016) about ADHD-students often prefer and benefit from CAI, and interview respondent 7 reports that “Games can often affect the ADHD students in a positive way”.

As with the literature review, some terms and phrases emerged as recurring to a high degree. Even with the respondents’ different professional roles, there was little ambiguity in how
ADHD expressed its symptoms. There also emerged a common theme for methods, used by the education professionals to mitigate some of the difficulties that ADHD-symptoms can bring to an educational environment. The most prominent method about how to include an ADHD-student in a general education was to structure the work. The term structure [Swedish: Struktur] was repeated multiple times by many of respondents, both from the pool of educators, and the pool of teachers' assistants (see appendix A). Some interview respondents defined working in a structured way as “inrutat”, schematically, and suggested this as a preferable method of structuring education for ADHD-students. This claim was treated as synonymous to structured.

The other prominent method that was mentioned by a number of respondents was to divide the tasks at hand into manageable and lucid sub-tasks. This would increase the overall motivation, and greatly increase the chance of the assignment being fulfilled. When these standards were not met, students could react by lashing out or retreating into themselves, resulting in a deficit of school work being accomplished. This implies a need for a structured environment comprised of many, but achievable, tasks. The interviews were transcribed and translated (see appendix A) and the descriptive terms and phrases emergent from the transcription were added to the synthesized terminology (see figure 5).

### 4.3 Result of survey

To further ensure that the identified terms in the synthesized terminology hold merit and are representative of the general image of ADHD traits and symptoms held by educational professionals, the terms were summarized in a survey where the respondents were asked to rate how well each term applies to their individual view of ADHD traits and symptoms, in a scale of one to six, where one equals a low degree of accordance, and six equals a high degree of accordance. In the survey, the terms were arranged in alphabetical order, as contrary to order of prevalence, to prevent an obvious pattern of decline in validity. The respondents consisted of the special pedagogues who was listed as employed in one of the largest municipalities in Sweden. and had their contact information listed on their schools’ website. A total of 55 respondents were selected to receive the survey. Out of those 55, a total of 15 responded in the three-week period assigned to the survey study. That equals a response rate of 27%. Along with the invitation to the survey, a short introductory text was included, to explain the nature and context of the study, as this might further mitigate the general low response rate that surveys are at risk of receiving (Bryman, 2011). To assign the statements a compiled variable of agreeability once the survey was complete, the total number of rankings were added to a sum and then divided by the number of respondents. This variable constituted the rank of the descriptive term or phrase for the final glossary, and is referred to as accordance rating, or AR. The AR is calculated by dividing the sum of the total ratings divided by the total number of respondents.

Some statements scored a consistent and high rate of accordance with the respondents, like the statement “apparent need for structure”. This statement was answered with thirteen instances of the maximum rank, 6, and two instances of 4 and 5 respectively (see figure 6.) Applying the calculation for accordance ((6*13+4+5)/15), this would give the statement an accordance rating (AR) of 5.8 out of a total 6.
Some other statements scored lower in agreeability and had a wider spread of respondents’ accordance. The statement “difficulty initiating” results in the accordance rating (AR) 3.1 \[\frac{(1+2*5+3*2+4*5+5*2)}{15}\].

The accordance rank of the statements statement “abnormal sensitivity to positive and negative reinforcements” (AR 4.6), “Benefits from CAI (Computer assisted instructions)” (AR 4.2), “Need for structure” (AR 5.8) and “works better with subtasks” (AR 5.6) could all be interpreted as a positive indication on the application of serious games to the education of ADHD-students. For summary of the survey responses with AR calculations, see appendix B, and for final glossary with AR, see chapter 5.

4.4 Summary

This study identified descriptive terms and phrases associated with the diagnosis ADHD in literature and the common discourse of professional educators. The identified language was then ranked by special pedagogues via a survey, and assigned a numerical rating in agreeability in accordance with their answers. These steps yielded a glossary of descriptive terms and phrases found in peer reviewed material and the common discourse of educators, validated by special pedagogues to be used as a short-hand introduction to what aspects of the diagnosis may merit particular focus when designing serious games for students with ADHD.
The literature study also yielded numerous descriptive terms that are associated with ADHD, apart from the three main traits inattention, impulsivity and hyperactivity. These descriptions include having difficulties to visualize goals and difficulty initiating tasks (Furtick, 2010), low attention to details and difficulties following instructions (NCCMH, 2009), an abnormal sensitivity to reinforcement, and the habit of “goofing off” when trying new things to avoid the experience of failing at a task (Schultz & Evans, 2015). A total of 37 descriptive terms and phrases were identified from the data gathering process. For complete list of terms and their sources in a taxonomy table, see chapter 5.

Both prominent methods discovered by interviewing the educational professionals; structure and lucidity, and the division of tasks into sub-tasks makes the prospect of a video game format promising, because video games have an inherit structure as they are comprised of a series of systems, and are commonly divided up in lucid segments (levels, tiers, etc.). The literature review also suggested that one of the main traits of ADHD, inattention, can be mitigated by playing simple games, a claim that was repeated in some of the interviews (see appendix A). The AR of the survey study asserted this further by assigning the statement “Benefits from CAI” the AR 4.2. During the summary of the final iteration of the glossary, after the survey study was completed, the similar descriptions “cannot wait their turn” and “impatient” also received an identical AR of 4.6, and was due to their synonymous nature and ranking merged into one description, “impatient”. No description from the survey scored lower than 3.0 AR, and the highest AR was a 5.8 out of a possible 6. The descriptions are presented separately in appendix B, to showcase the survey responses, but are both represented under the term “impatient” in the final glossary, chapter 5.

Besides the most commonly occurring terms inattention, hyperactivity and impulsivity, much of the reviewed literature had some focus on the social difficulties of ADHD-diagnosed children. This aspect was also brought up during 3 of the interviews, suggesting that inadequate social relationships with one’s peers is a very common effect of the ADHD diagnosis. Two of the interview respondents also brought up the fact that ADHD traits are very diverse and that the effects are very individual across the board. This statement is omitted in the taxonomy table, as the taxonomy’s purpose is to juxtapose traits that are common and prevalent among ADHD-afflicted students.
5 Results

Listed below is the final glossary of descriptive terms and phrases, presented with their respective sources and AR-score. The following format is employed: Term source (AR). The sources for each term or phrase is listed in a separate list on the following page.

<table>
<thead>
<tr>
<th>Term</th>
<th>Source(s)</th>
<th>AR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Need for structure</td>
<td>5</td>
<td>5.8</td>
</tr>
<tr>
<td>Works better with subtasks</td>
<td>5</td>
<td>5.6</td>
</tr>
<tr>
<td>Easily distracted</td>
<td>1,6,9,11</td>
<td>5.4</td>
</tr>
<tr>
<td>Difficulties being still/calm, fidgety</td>
<td>4,5,9,11</td>
<td>5.1</td>
</tr>
<tr>
<td>Hard time keeping/maintaining Focus</td>
<td>4,5,9,11</td>
<td>5.0</td>
</tr>
<tr>
<td>Short attention span</td>
<td>4,5,9</td>
<td>4.8</td>
</tr>
<tr>
<td>Interruptive</td>
<td>1,9,11</td>
<td>4.8</td>
</tr>
<tr>
<td>High Impulsivity</td>
<td>1,6,7,9,10,11</td>
<td>4.8</td>
</tr>
<tr>
<td>Disorganized</td>
<td>3,7,9</td>
<td>4.8</td>
</tr>
<tr>
<td>Blurs out answers and communications</td>
<td>4</td>
<td>4.8</td>
</tr>
<tr>
<td>Aggression</td>
<td>1</td>
<td>4.7</td>
</tr>
<tr>
<td>Mood swings</td>
<td>1</td>
<td>4.6</td>
</tr>
<tr>
<td>Low time management skill</td>
<td>7</td>
<td>4.6</td>
</tr>
<tr>
<td>Impatient</td>
<td>1,5,9,11</td>
<td>4.6</td>
</tr>
<tr>
<td>Hard time visualizing goals</td>
<td>3</td>
<td>4.6</td>
</tr>
<tr>
<td>Abnormal sensitivity to positive and negative reinforcement</td>
<td>5,7,11</td>
<td>4.6</td>
</tr>
<tr>
<td>Hyperactivity</td>
<td>1,6,7,9,10,11</td>
<td>4.5</td>
</tr>
<tr>
<td>Difficulties following instructions</td>
<td>1,9</td>
<td>4.5</td>
</tr>
<tr>
<td>Difficulties with social interactions</td>
<td>1,2,4,5,7</td>
<td>4.2</td>
</tr>
<tr>
<td>Benefit from computer assisted instructions</td>
<td>2,5,7,8</td>
<td>4.2</td>
</tr>
<tr>
<td>Goof off when trying new things</td>
<td>4</td>
<td>4.1</td>
</tr>
<tr>
<td>Motivated by rewards</td>
<td>5</td>
<td>4.0</td>
</tr>
<tr>
<td>Excels at practical subjects</td>
<td>5</td>
<td>4.0</td>
</tr>
<tr>
<td>Disruptive behaviour/ loud &amp; noisy</td>
<td>2,3,5,9,11</td>
<td>4.0</td>
</tr>
<tr>
<td>Easily overwhelmed</td>
<td>3</td>
<td>3.8</td>
</tr>
<tr>
<td>Inattentive</td>
<td>1,6,7,9,10,11</td>
<td>3.7</td>
</tr>
<tr>
<td>Forgetful</td>
<td>1</td>
<td>3.7</td>
</tr>
<tr>
<td>Communication problems</td>
<td>4</td>
<td>3.7</td>
</tr>
<tr>
<td>Non-compliant</td>
<td>1</td>
<td>3.5</td>
</tr>
<tr>
<td>Lower grades/academic performance than their peers</td>
<td>1,5,11</td>
<td>3.5</td>
</tr>
<tr>
<td>Immature language</td>
<td>1</td>
<td>3.3</td>
</tr>
<tr>
<td>Rarely asks for help</td>
<td>1</td>
<td>3.2</td>
</tr>
<tr>
<td>Low attention to details</td>
<td>1,9</td>
<td>3.2</td>
</tr>
<tr>
<td>Difficulty initiating</td>
<td>3</td>
<td>3.1</td>
</tr>
<tr>
<td>Clumsiness</td>
<td>1</td>
<td>3.1</td>
</tr>
</tbody>
</table>


3 Furtick, K. (2010) Successful strategies used with ADHD students: is an ADHD classroom a possibility? Proquest LLC.


5 Personal communications with professional educators (see appendix A).


6 Example Artefact Development

To illustrate how the glossary presented in this paper can be used as the basis and design rational in the development of a serious game for the education of students with ADHD, a design document of a hypothetical example artefact is presented. The example design includes a subjective selection of terms from the glossary, and rationalizations on how those terms are interpreted and translated into game mechanics.

6.1 Example design rationale

Out of the total 35 descriptive terms and phrases in the glossary, this example employs 14 of those descriptions as design basis. The selection process of narrowing down the glossary was done in a subjective way, as it is expected to be employed by serious game developers. Generally, it can be encouraged to focus on descriptions with an AR-score of 3.5 or higher, as those terms ranked above the mid-way value. These 14 descriptions are not meant to illustrate the most relevant or optimal terms to focus on, but merely to illustrate a subjective creative interpretation of the glossary. The terms selected for this example were:

- Need for structure (5.8 AR)
- Works better with subtasks (5.6 AR)
- Difficulties being still/calm, fidgety (5.1)
- High impulsivity (4.8 AR)
- Blurs out answers and communications (4.8 AR)
- Low time management skill (4.6 AR)
- Hard time visualizing goals (4.6 AR)
- Abnormal sensitivity to positive and negative reinforcement (4.6 AR)
- Benefit from computer assisted instructions (4.2 AR)
- Goof off when trying new things (4.1 AR)
- Motivated by rewards (4.0 AR)
- Easily overwhelmed (3.8 AR)
- Forgetful (3.7 AR)
- Rarely asks for help (3.2 AR)

Adhering to the glossary, this design example aimed specifically at students with ADHD needed to be perspicacious and lucid, and always display the end of the assignment or task within the field of view, to mitigate the loss of focus and deter the student from giving up. It is therefore comprised of small segments and many small sub-tasks that constantly give some positive feedback when completed, to accommodate for the ADHD-afflicted students need for reinforcement. Structure and sub-task division are not uncommon game mechanics, and the use of a similarly structured set of levels can be argued to fulfil those requirements. Difficulties being still, and being fidgety received an AR of 5.1, and is represented in the design by having a simple keyboard input, and when the player presses different keys than those intended for game play, no other actions occur (with the exception of the escape key, which opens up a
window for exiting the game). The traits of high impulsivity and the habit of blurting out answers was accommodated for by not having a penalizing system for erroneous answers entered and being forgiving of hasty impulse inputs. The trait “low time management skill” was accounted for in the design, not as a therapeutic opportunity for improvement in the area, but as a way to accommodate that trait without penalizing it; the player does not suffer any disadvantage if he or she takes too long to solve the task, as contrary to the serious game *Algebra Champ* where a ticking timer hints on how efficient the player is using the time spent playing (Sullivan-Carr, 2016). This can also be favourable to the trait “forgetful”. To mitigate the trait “hard to visualize goals”, the end point of the level is always visible within the game screen and field of view, so the player always knows which point to steer towards. The traits of sensitivity to reinforcement and rewards is also something commonly found in game designs, and is here included by a small, constant reward and reinforcement for each subtask solved. Having the game played on a digital platform accommodates for the positive results of the benefits of CAI for ADHD-students (4.2 AR). The habit of ”goofing off” when trying new things combined with the trait of rarely asking for help was included in the design by making the interactions and inputs intuitive, and the game play include few elements; moving in a 2-dimensional space towards different locations. And to keep the player from being overwhelmed, the game design example does not include any sudden fluctuations in difficulty or change in mechanics.

### 6.2 Ludic interface

The subjective interpretation of these design specifications led to a game consisting of several maze-based levels, where the corridors are blocked by locked doors or objects. To reach the levels end point, these doors or objects need to be unlocked by solving a small task. The task could be a simple math problem, or a word needing to be translated from one language to another, depending on what subject the game is currently being applied in. Solving these small tasks will reward the player with some arbitrary currency or medal. When a sufficient number of tasks have been completed, the way to the levels end point is clear, and the player can advance to the next level. In this design, there are layers of goals and sub-goals. Where the outermost tier goal is to increase your academic skill via repetition, the medium tier goal is to complete the level and accumulate as much currency as possible, and the inner tier goal is to complete the task in front of you for an immediate reward. This structure and hierarchy of goals can sustain a players’ motivation when applied in an educational game (Fui-Hoon Nah, Rajasekhar Telaprolu, Rallapalli, Rallapalli Ventanka, 2013).

To mitigate the trait described as “difficulty visualizing goals” (4.6 AR) the maze-based levels always have the end-point within the field of view. A visual indicator can be added to further ensure that the goal point can be easily identified at the start of the level. The tasks commonly found in a school book here take the shape of obstacles that need to be removed in order to progress through the level, which gives a degree of motivation for solving the task. A reward will spawn for each task solved, and can vary in accordance to how difficult the task is. The instant spawn of a reward keeps motivation up by constantly confirming that the student is performing well. The total number of rewards should always be displayed, to illustrate their progression. An arbitrary goal can be set by the teacher in the beginning of the lesson, e.g.
“Score 50 points before the bell rings”, which can be assumed to be more motivating to a young mind with ADHD than the standard textbook approach when engaging in a repetitive task.

The level will repeat in a slight variation, as to always be familiar and not include unexpected surprises which was described as detrimental to ADHD-students’ performance by the interview respondents. While this can be counter-intuitive to fun and excitement, the design shares this element with its contender, the standardised textbook.

6.3 Narrative context

To coat a ludic interface in a theme is a way to make the game more visually appealing. This specific thematic narrative was not based in the glossary, nor chosen to be especially well suited for special education, as it was an entirely subjective design initiative. The narrative chosen for this example is a dragon raiding castles for gold coins for his hoard. It is an element familiar to many children as dragons and castles and gold appear frequently in many children’s stories. The hindrances take the form of treasure chests that need to be puzzled open by solving a task, in this example, a simple math question. The chests come in two colours, where the gold variation present a harder puzzle to solve, but give a greater reward. The levels end point is illuminated by a glowing torch (see figure 9, bottom right) with a slight flickering animation, and the total amount of gold coins gathered are displayed at the bottom of the screen.
6.4 Design reflections & summary.

This design solution is included as an example of how the descriptive terms found in the glossary could be applied to the design process. The example artefact illustrates a possible outcome of applying the glossary’s specifications, as an alternative to a standardised curriculum method of text book education, presented with a common children’s story theme containing dragons and castles. The selected descriptions chosen as the basis for this example design was subjective, and their interpretations into game design elements is not meant to illustrate an optimal interpretation of the glossary.
7 Analysis

This paper includes a discourse analysis and terminological summary of how the neurodevelopmental disorder ADHD is described in different domains; research articles focusing on serious games or special education, clinical diagnostics criteria from the diagnosis, and the common discourse used by professional educators with real-world experience working with ADHD-students. Here follow the notions that became evident as they we’re repeated between domains, or multiple times within the same domain.

Evident from the interview phase of this paper, and supported by the similar results in a paper by Nowacek & Mamlín (2007) is the notion that professional educators often have an experience in working with children with ADHD, and a general grasp of what the diagnosis implies on a practical level. With the high prevalence of ADHD in mind, this can also be thought of as an unavoidable part of a teaching career as two children in every classroom is estimated to exhibit ADHD-traits (AAP, 2011).

Both literature (Roh & Lee, 2014; Bul et al. 2015; Sullivan-Carr, 2016) and interviews had positive expectations and experiences with the education of ADHD-students with CAI in the form of computers, tablets or smartphones. This notion was phrased as a statement in the survey study, and received and AR of 4.2 out of a possible AR of 6. The benefits of CAI in the education of ADHD-students is expressed in multiple domains. This can add credibility to the positive expectations of using digital games as an educational tool in the context of ADHD.

The interviews conducted as part of the study allowed an insight into what methods and approaches was used by the interview respondents in their profession to accommodate ADHD-students in the curriculum and classroom environment. Two recurring responses was to have a clear structure, and the method of subdividing tasks into smaller, achievable sub-tasks. These observations can further validate the positive expectations of using digital games in ADHD-education, as these methods of lucid structure and sub-task division are commonly found in games (for example the game mechanics of employing levels and tiers to illustrate progression in repetitive processes, using achievements as milestone markers, or dividing an epic quest in multiple levels).

Illustrating how the glossary can be applied in a development and design process, this study provided a tangible example based on 14 terms and phrases. The terms and phrases used in the example were subjectively selected. The glossary also contains descriptions that may not be obviously or immediately translated into the context of game design. However, that subjective assessment is left up to the creative interpretations of the developers that might seek to employ this glossary.

Designing a serious game demands an expertise in game design, as well as expertise in what ever field the serious game is meant to be applied to. Relying on the expertise from external sources as consultants is a practice that alleviates the burden of expertise from the developers, allowing them to harness the knowledge in a time efficient matter. The glossary presented in this paper is a synthesized product of the language used to describe ADHD in different professional domains.
8 Conclusions

The research question this paper focused on was:

What problems could be significant for developers to keep in mind when designing educational games specifically for ADHD-students?

This question has been answered by constructing the glossary and ranking the descriptive language in accordance to the validation index AR.

With the confirmed claims of a beneficial effect of using CAI in ADHD-education, and the unison in the methods of structured, subtask-based procedure, there is good reason to accept the positive claims and expectations expressed in the background literature. This suggests that students with ADHD can benefit from serious games methods in their education. What now remains is to narrow and concretize the design specifications, to streamline the developed tools to their best potential.

8.1 Summary

By synthesizing the perspectives of multi-disciplinary literature and real-world situations of professional educators into a terminological taxonomy, and having those descriptions rated in terms of agreeability by special pedagogues, a glossary with occurring and representative terms was constructed. The goal of the glossary is to serve as a short-hand introduction to what problems and difficulties can be associated with an ADHD diagnosis when designing educational games aimed at the afflicted target group. The final glossary contains 35 descriptive terms and phrases, and is presented with its sources and a numerical representation of agreeability in chapter 5. To illustrate how the glossary can be applied as a design basis, an artefact was designed, and presented as a tangible example.

8.2 Discussion

The glossary is here argued to provide a representative depiction of some of the traits associated with an ADHD-diagnosis. However, until any artefact developed with this taxonomy as a design basis has been properly field tested, it remains an unsupported claim. Any conjecture of how well-adapted this glossary to serve as a design basis needs to be validated and evaluated.

8.2.1 Ethical considerations

This paper’s focus is on children with neurodevelopmental disorders and their educational environment. As this is a sensitive and important subject involving children, the research was designed in a way that the researcher was not in direct contact with any afflicted individual. The burden of expertise on this subject was placed solely on the literature and the respondents. This paper claims to present a preferable approach when designing educational situations for children with ADHD, and any illegitimate opinions on that matter was to be avoided. Therefore, each description included in the glossary is presented with its sources as well as its AR-score. It is intended that no presumptions or biased expectations represented in the authorship of this paper has made it into the final glossary.
Basic research ethics in the social sciences includes voluntary participation, integrity, confidentiality and anonymity for those involved in the research (Bryman, 2011, p. 131). The respondents participating in the interview procedure was to be treated in accordance with these ethical requirements. As such, they were informed that the interview procedure was to be recorded, and their consent to being recorded was captured on the recording before the interview could proceed. Any information that could compromise their integrity or anonymity was omitted from the published material. The geographical location, age, sex and name was removed from any documentation. Their occupation is listed, as it is relevant to their expertise on the subject, but they are referred to only as a number in this material. The same procedure was relevant to the survey respondents. They were invited to participate in the survey via a short introductory text, that explained the nature and aim of the research, and were told that participation was voluntary, and that no personal data would be gathered or registered.

8.2.2 Background literature bias
A motivation for this study was the enthusiasm found in the background literature, which expresses positive expectations in the anticipation of how well the reported increases in motivation and attentivity associated with serious games will transfer to the area of ADHD-education. The reviewed material was almost unilateral in the expectancy of positive results of applying serious games in the special education. And even as the material that included a review or evaluation of a serious game reported success, those success factors were not always satisfactory. For example, in the development and evaluation of a digital educational tool, Wronska, Garcia-Zapirain & Mendez-Zorilla (2015) the evaluation was focused largely on user experience, even as the proclaimed goal of the educational tool was to increase reading comprehension. To evaluate the success rate of the proclaimed goal of reading comprehension, the study presents the game score and play time of three sessions, which does show an increase in mean score and a decrease in time spent achieving the score. But any implication of the effect this might have on the reading comprehension of the player is not measured. Another example is how the development and evaluation of the serious game Plan-it Commander by Bul et al. (2015) presents the results of two evaluations, where one is the pre-test expectations of the game expressed by parents of children with ADHD, and the other is the children’s satisfaction after playing the game. No results from any therapists, pedagogues or psychiatrist’s perspective was presented, and the study concludes with the pre-test expectations and the children’s perceived satisfaction. The parents reported high expectations on the game, and the children responded with and over-all high satisfaction. Although these results are indeed positive, the foci of the results can be argued to be skewed. The current pool of literature might be saturated with enthusiasm, and in need of some scrutiny.

8.2.3 Bilingual terminology
The data gathering and validation in this study was conducted in two languages. The bulk of the literature was in English, with the exception of the clinical document from the Swedish Medical Product Agency Läkemedelsverket (2009). The interviews and survey studies were meant for Swedish speaking participants, and the terms emerging from the interviews were translated into English and paired with the terms from the literature study. The English first iteration of the glossary was then translated again into Swedish for the survey study.
The technical terms found in the clinical literature were available in both languages, and in no need for translation or interpretation, and the majority of the other descriptions were formulated in a prosaic and common discourse. With the risk of nuances getting lost in translation, the conversion was relying on the author’s fluency in both languages. One example of a phrase that was at first compromised by unsatisfactory translation was the Swedish interview response “cannot wait their turn”, which was presented as a stand-alone phrase in the survey. The separate term “impatient” was presented separately despite the similar nature and implications of the two descriptions. First once the survey was returned and the AR-score visible, the identical AR of 4.6 motivated that the two statements be merged under the term “impatient”. Other than the redundant synonym published in the survey, no other translation errors have been discovered.

Other than pure language differences between literature and respondents, there is also the fact that British, Swedish and American school systems differ. The background literature also includes other cultures, as the study by Roh & Lee (2014) is conducted in South Korea. Teachers in different cultures may very well be educated on the diagnosis in different ways, and taught separate approaches. How this affects the perspectives presented in this paper is hard to rationalize, but where ever the literature was published, the main diagnosis criteria, inattention, impulsivity and hyperactivity, was present. The traits of the diagnosis can therefore be assumed to be trans-cultural.

### 8.2.4 Response rate of survey

Even with the low response rate of the selected method in mind, the 27% response rating could endanger the possibility of re results being representative. At a response rate lower than 50%, Bryman (2011) warns that the answers risk representing a bias, as there is some factor separating those who chose to respond, and those who did not. Some of the survey respondents replied to the invitation e-mail to inquire more about the study, and expressed a sceptic view of the statements in the study, and expressed a sceptic view of the statements in the study, and some respondents even admitted to finding the survey offensive. An unforeseen result of the survey was the AR of the three clinical terms inattention (3.7 AR), hyperactivity (4.5 AR) and impulsivity (4.8) (see figure 10). For terms being expressed in specialist literature such as Läkemedelsverket (2009), NCCMH (2009) and the DSM-V, a much higher AR was expected, as these terms were often expressed as diagnostic criteria. The low agreeability on these terms from the perspective of special pedagogues might imply that the key terms are outdated.
The dissonance between the clinical language and the expectation of the special pedagogues ranking of those as representative descriptions of the diagnosis might suggest an ambiguity in how prevalent the key traits are perceived in the literature and in the opinions of special pedagogues.

8.2.5 Example design reflections

The example design in this paper is included to illustrate one possible interpretation when using the glossary as a design basis. Some design solutions might be considered contrary to conventional “good” game design, as sacrifices were made to traditional mechanics to make the design example more suited for an educational environment with the needs of ADHD-students in mind. For example; the common game element of a boss-fight, a sudden increase in difficulty and culmination of skill being needed, was completely discarded to accommodate the glossary’s specifications. What remains is a repetitive and droning interaction. But the contender to this design is a standardized textbook, which also often is repetitive and tedious to students with concentration impairments. There might not be any escaping the fact that repetition is an integral part of the educational standard, and a true and tested way to learn. In this aspect of education, the role of the game designer could be to make that repetition as engaging as possible. The example also contained a narrative theme, which was not based in the glossary or any pedagogical theory, but merely a suggested design approach.
8.3 Future Work

The glossary this study resulted in is meant to be applied to a game design situation. The notion of using serious games in the education of ADHD-students is talked about with positive expectations, and with good reason. It would seem that looking at the problem areas of an ADHD-diagnosis within the educational environment and comparing it to the positive effects of educational games, a positive expectation seems reasonable. However, the studies found during the literature review process that contained any evaluation or testing when educating ADHD-students with games reported results either with a skewed focus, or within a short time period where any measurable long-term effect would not be visible. More structured studies focused on increased academic results and performance is needed to validate these expectations.

ADHD is not restricted to one single age group, and can affect adults as well as children. The focus of this paper, and the majority of the literature, was on children in elementary school age. Perhaps this age is when the traits of ADHD is the most prominent, but the field would benefit of research focused on a wider range of ages. If the traits of ADHD are similar independent of the afflicted individuals age, there should be some degree of transferability in the design specifications.

The next and necessary step to validate this glossary would be to develop a serious game based on the descriptive terms and phrases presented and test that artefact in an educational environment. The basis of the glossary is multi-domanial, but it does not yet hold any applicational merit, and the expected positive outcomes of focusing on the specification is not confirmed. An evaluation study with participants containing students with ADHD and their teachers playing a serious game based on the glossary could justify the positive expectations of the design specifications that this study presents.
References


Berg-Marklund, B, (2015) Novices Vs. Experts; Game-Based Learning and the Heterogeneous Classroom Audience. University of Skövde: Sweden


Furtick, K. (2010) Successful strategies used with ADHD students: is an ADHD classroom a possibility? Proquest LLC.


Appendix A - Transcription of Interviews.

Organized into the topics of the prepared questions written in advance of the interviews. Personal communications unrelated to the topic is omitted, and apropos statements are moved into their respective topic. Each interview was preceded by the question “Do you consent to the recording of this conversation?”, and did only proceed if the respondents answered “yes” on the recording.

Interview 1

I: *Can you describe what traits and mannerisms you perceive in students with ADHD?*

R: He can’t really be still, he's not able to for too long. Maybe for a little while, then he wants to go and do something else. Makes a lot of noises, like to bother his... oh, and he got his diagnosis recently, so this is very new for him. And we’ve had a student earlier who had had his diagnoses for longer, so he might have picked up his behaviour from him. But that is much the same, work a little bit, then go outside to run about, then work some more. And so on.

I: *Can you describe how those traits affect the academic performance of those students?*

R: Well, it is of course harder to achieve the goals we have, as he’s not really able to be present all the time. But in some subjects, he's better, and wants to put some effort into. While those subjects he doesn’t feel as he’s good at, he's not able to, and he doesn’t even want to sometimes. [In the subjects he prefers] he is still performing at a normal level compared to his class mates. I’ve only had him since fourth grade, and I’ve been told there is a big difference on how he behaved before he got his diagnosis, as compared to afterwards. Now he’s not able to as much, or doesn’t want to as much, but he’s still good. That depends on our approach. Should we force him to sit with the school books, or should we let him do something else, like play a game, or do an oral presentation.

I: *Can you describe how those traits affect the classroom environment?*

R: It varies. Some days we’re all affected a lot. Negatively. He’s loud, runs about, wants to create conflict. But the students have started to get accustomed to it, so they’re not as disrupted as they used to become. Depending on what level it is. They can ignore him more, and not affirm him, which is what he's usually after, [affirmation/attention]. We have a resource personnel, who’s here on behalf of another student, but he has to attend this student as well, and help out. He takes the student out of the classroom, so the other children can get a better study environment. And then some days we are not affected at all, if he can sit with his ear phones and play with his iPad, and the rest of us can then continue work as usual. Often, but from day to day.

I: *Are there any traits that you perceive as universal to ADHD students?*

R: Both, I have tried different methods, but what I have tried that works good on both diagnosed and undiagnosed children is a change in the format, not only just sit still and write or read, just change something so it doesn’t get too boring. Games are much easier, you get the instant gratification, instantly know if you solved it correctly. I have 1 student, neurotypical, she prefers the school books to games.

I: *What methods do you use to cope with, or mitigate, these traits?*
Sometimes we go to a different, separate room, where he sometimes can sit by himself or with a teacher or resource, sometimes it’s enough to just let him have ear phones, or a tablet, some thing else. We can provide him with another learning material, often easier. As for now it is not possible to reach all the way in terms of marks and completing the grade. This phase has more focus on teaching him how to study, how to be in school. A study habit. The most important thing isn’t specifically so teaching him to write with a pen on paper, he does better writing on keyboard or iPad. It’s faster and doesn’t demand so much of him. In math and English we do a lot of math games. The students usually prefer games. I use the zcooly platform.

**Interview 2**

*I: Can you describe what traits and mannerisms you perceive in students with ADHD?*

R: Since I have the subject wood shop, there are many opportunities to move and be active, which can be fitting these [ADHD] students. They often enjoy wood shop class, so it can turn out very well.

*I: Can you describe how those traits affect the academic performance of those students?*

R: They can often perform better than their neurotypical class mates in wood shop.

*I: Can you describe how those traits affect the classroom environment?*

R: They can be very demanding, when they are very active, I often need to prioritize those students at the cost of the rest of the class. Having a hard time waiting their turn. Then it also depends on how well the other students can accept this, how independent they can be. So it might not always be fair, the amount of attention. These students might get a bit more than the rest.

*I: What methods do you use to cope with, or mitigate, these traits?*

R: We have a que system, and they have to follow the same rules as anyone else, but you have to *look between your fingers* sometimes, so they don’t explode. I often teach class outside, in the woods to whittle and chop wood, where it often works even better. Fresh air and physical work. They need an outlet for their energy.

**Interview 3**

*I: Can you describe what traits and mannerisms you perceive in students with ADHD?*

R: Most obviously it’s the restlessness and acting out that the most prominent, and that’s the big problem. With focus. They get hung up on some things, details, and lose focus very fast. Then it’s hard to get focus back on the school assignments, easily distracted and lose focus fast. They want to do something fun all the time, it’s always pulling towards that. That is the most obvious.

*I: Can you describe how those traits affect the academic performance of those students?*

R: Some have no trouble at all with reaching the academic goals, and are very skilled, we work in short intervals and they learn and retain everything. While some others lose/drop everything very fast and have a hard time to achieve the goals. And get stuck way behind. What
that depends on is beyond what I know, variations in diagnoses or something, hard to be sure. ADHD is not always equal poor academic performance.

I: Can you describe how those traits affect the classroom environment?

R: This is the biggest influence, it can be a big minus to sit with the rest of the class, but as soon as you sit in a smaller group it all gets a lot easier. And that’s mostly due to the flexibility, working in short intervals, to hold focus in that interval. I work a lot with sub-goals, short intervals, so we don’t always follow the schooling schedule, but adjust it after what they manage and what they know. We do as much repetitions as we can. [ADHD] is most apparent in the social situation, you often get a negative role in the classroom, and get that as a stamp on your person, which can be very hard to break away from. Hard to break the trend. But it of course depends on the situation.

I: Are there any traits that you perceive as universal to ADHD students?

They are all different, very hard to be specific. Different diagnosis. No child is the other alike. What they know and don’t. Generally, they have a harder time with language, they struggle a bit. Practical subjects are more fun and easy in general. Even if it’s not always like that.

I: What methods do you use to cope with, or mitigate, these traits?

R: Work short intervals, shorter assignments, often on a lower academic level so they can manage. In some subject the can be amazingly good, with no problems at all, and some subjects are harder, so we aim for an E-grade. So they don’t get this pressure. When they feel that they can’t do it, and need confirmation on their skill, it is also very important. One of the hardest things is that they want to be able to, but if they can’t’ they quit. It’s better if they get to build some confidence, we try to work with confidence. You change the lesson plan depending on their skill, very individually adjusted.

I: So, you they get the proverbial carrot, they tend to continue working better?

R: Yes, exactly.

I: Any methods including games and play?

R: Sometimes as a reward, we can play some cards or something, and I can try to tie that to the lessons.

Interview 4

I: Can you describe what traits and mannerisms you perceive in students with ADHD?

R: Lots of energy, hard time sitting still, hard time keeping focus. Some have difficulties with the social aspects, with other children. Likes things structured... But everything is different from child to child.

I: Can you describe how those traits affect the academic performance of those students?

R: That depends on how severe the ADHD is. Many children can’t manage to be in large groups with lots of noise. They want peace and quiet. Their brain absorbs so much, so I can get chaotic. But by gradually exposing them they can get integrated in the classroom. What I’ve noticed, and if I’m still there with them, as a safety. And I can tell if it’s about to go south.
**I**: Can you describe how those traits affect the classroom environment?

R: Well, if it’s awfully loud with screaming and kicking, and all that, it of course affects everyone. The child with ADHD feels bad, and their classmates too. It has a negative impact on them too, it effects their study environment. But on the other hand, I often see the classmates being incredibly understanding towards [ADHD] if you explain it to them. If you say “some things are like this with this individual” they understand. But that’s kids for you.

**I**: What methods do you use to cope with, or mitigate, these traits?

R: I think you really need to have a good relationship with the child, respect each other. You help each other. Good parent contact helps, if possible. If they can have it very structured, so they feel the structure, they have a schedule, from Monday to Friday.

**I**: If I may suggest the term “structure”? Is that akin to what you mean by [structure by another word]?

R: Yes, that’s the same.

**I**: Ok, good. Do you use any other tools in the education, games or the like?

R: I use my dog a lot. Many children like animals, and I have an unusual breed. And as an adult you need to show that you have flaws too and be able to apologize. The relationship is better if they know you are human and sometimes wrong.

**Interview 5**

**I**: Can you describe what traits and mannerisms you perceive in students with ADHD?

R: Hard time being still, losing concentration, tired, not as active. Quickly get tired, and then need to move.

**I**: By “active”, do you mean as in physically, or active in the school assignments?

R: Not as active in the school work. But hard to be still in the classroom. And can’t hold the concentration up. Hard to keep their focus on one thing.

**I**: Can you describe how those traits affect the academic performance of those students?

R: You really need structure, a clear structure. Shorter work intervals. Help them find study motivation. Make them believe that they know more that they know. At this age they discover that they might not be like the others [students], and you need to elevate them. Give them confidence. It can be very different from individual to individual. But I always keep them in the front [of the classroom] so I can intervene. Have a clear start on the lessons, and a clear end. I have to help them getting their study material and show them where they should start. Clear instructions.

**I**: Can you describe how those traits affect the classroom environment?

R: It affects us. It distracts. They need their answers straight away and can’t wait their turn. When the fidget it can be noisy, and talk with their classmates, so it affects the work environment, naturally. More conflicts. And there’s also a lot of extra meetings and stuff like that, that can take time. Some students would be better off being medicated, so they can find
their calm. It would help them. But you can’t just give them, many years are wasted. On investigations.

I: Are there any traits that you perceive as universal to ADHD students?

R: Some are of course very outwards, and aggressive. But not everyone, some are very quiet. So you can see some traits, and the most obvious is that they can’t be still. Need to stand up and walk about, fidget with things, draw or paint. Maybe need help reading.

I: Have you tried any additional tools or resources in the education of these students?

R: I have tried “seriesamtal”, where they draw different situations and narratives to help them understand better. But that doesn’t work. I often get that tip from special educators, to try “seriesamtal”, but it doesn’t work. It’s old hat.

I: What methods do you use to cope with, or mitigate, these traits?

R: Shorter working periods. They get to go outside and run about for a bit. We have small signs in the class, so we don’t need to talk, they can just get up. Clear structure, as I’ve said. They should know how the day will look, what people they will meet, any changes.

I: So no surprises?

R: No, that won’t work. Planning and letting them know, changes in the schedule. So you need to know everything about that.

I: And what happens if you fail with informing them?

R: They can just refuse. “I won’t participate”. But you know, there are many of them who doesn’t only have ADHD, it can be a mixed diagnosis, with Autism for instance.

Interview 6

I: Can you describe what traits and mannerisms you perceive in students with ADHD?

R: That our structure is totally crucial to how they will manage their education. By that I mean that if we don’t have a structure that’s fitting to these children, their needs, then all of their difficulties and challenges emerge.

I: Can you describe how those traits affect the academic performance of those students?

R: I believe that the structure you create, gives the student a calm working environment. That is the best way to get a child to develop its educational knowledge.

I: Can you describe how those traits affect the classroom environment?

R: It’s not always a negative impact, I believe. They don’t always throw chairs about. You need to know the difference between an outburst and a break down. But if all the students learn how to be in a classroom environment, the children who need more peace and quite will adapt.

I: Are there any traits that you perceive as universal to ADHD students?

R: Similarities are difficulties with social meetings. Hard time understanding other people’s perspectives. Often these children have trouble showing their true face. Other similarities... is
that they need to move. That’s why we feel they can’t be still. Most need to be active. But not all are hyper. And impulse control. If you’re extrovert, the lack of impulse control often leads to fights and conflicts, if you’re introvert it makes you sad and depressed instead. Another similarity you need to remember is that these students feel very bad about their failures. When they end up in a fight or with a bad mark, they have much higher demands on themselves than we know.

I: Have you tried any additional tools or resources in the education of these students?

R: We try to not leave the classroom too much, that depend on their needs. We have decisions from the student health team which we follow. So, we have had smaller groups, with more adults. The primary thing is to establish a good classroom relationship. The goal is that all students should be active and present in the classroom. But a calmer room as an escape can really help.

We use social stories [serieamtal], where we focus on conflict management. To draw situations to remember them, focus on facial expressions. You can also use colours in different ways. Things are written on the white board, but the student might not remember that anyway. So we write the subjects in their specific colours. And I imagine it’s easier to remember that way. Physical activities, it’s incredibly important to get an outlet for your energy. To get rid of energy, and then get energy. Break up the longer lessons with some physical activities. But what works for one child might not work for all.

I: What methods do you use to cope with, or mitigate, these traits?

R: The hard part is in the beginning, before you get to know the child. Even if they have a diagnosis where you have a hunch of how you should handle it, they are very different with different needs. So you need to find a structure that works, where the child knows what’s about to happen, and you cannot break that structure. You meet in the same way every day, start the lessons the same way every day. A clear goal or sub-goal. You need to be very clear with the size or length of the assignment. And once that is reached, you can’t push for more, you need to be consistent.

Interview 7

I: Can you describe what traits and mannerisms you perceive in students with ADHD?

R: No concentration. Hard time being still. Difficulties to work on longer assignments, can be a bit unruly, can’t really wait in line...

I: Can you describe how those traits affect the academic performance of those students?

R: ADHD, It’s very individual… some children have ADHD in combination with some other diagnosis. Like ADHD and autism. When it comes to educational situations and tests and such, their stamina isn’t too good. You need to adapt the tests, like give them a shorter time with breaks, explain it a bit more in detail. And then they often succeed.

I: Can you describe how those traits affect the classroom environment?

R: There is an impact. You need to be very structured as an educator. I actually work with the entire class in the same way, almost like everyone had ADHD. And I think no one gets a
disadvantage there, with more presentations, or a more structured environment. Many frames and lucidity. If you’re very extrovert, it can affect the classroom environment.

I: Are there any traits that you perceive as universal to ADHD students?

R: Difficulty being still, that’s the most prominent feature. Then there’s those who deliberately disrupts others, who wants to include others in their action. Approach them or touch them. Then others just needs to go outside or sit by themselves. And its very common for them to just blurt out things during lessons.

I: Have you tried any additional tools or resources in the education of these students?

R: We have some of the [ADHD] students in the classroom for presentations, and for some lessons. From the start they were meant to be in the classroom more, but it didn’t work. It affected the class, environment and education. I prepare them for how the day will look, a walk-through of the schedule every morning. Prepare them several days in advance for bigger changes. There can’t be any sudden surprises. If there is they can react strongly in different ways. They can become catatonic [or a milder variant of the term, directly translated from “locked”], angry, or sad.

Games can often affect the ADHD students in a positive way, they can express that they want to play a game for a while, so they can be able to be still and relaxed. And I clearly notice that they learn from games. For instance, English, the learn a lot from COTS games. We have increased English knowledge a lot. I can easily consider Minecraft as an educational game.

I: What methods do you use to cope with, or mitigate, these traits?

R: To be clear to everyone. But there’s a lot of individual adaptations. We can use different signs, if they feel that the need to take a break. Short presentations, but frequent. They have more deals with us, to allow them to go outside for a bit.

Interview 8

I: Can you describe what traits and mannerisms you perceive in students with ADHD?

R: The most obvious is that they are more active, more stuff happens than with other students. Often involved in more conflicts. Run around in the classroom, so you need to tell them off more than other students. But there are positive traits too, more curious, more inquisitive. It makes working with them more fun.

I: Can you describe how those traits affect the academic performance of those students?

R: You really need a good structure, and you need to adapt the assignments to fit the students needs. And you need to be patient. In the more practical subjects, like wood shop and such, they can often outperform their fellow students. But in theoretical subjects, it can be harder. Maths, language...

I: Can you describe how those traits affect the classroom environment?

R: If it’s an unruly class, it gets a lot harder. They have a greater need for order, so you often need to go to a separate room. And if there’s too much sounds or impressions, it can implode, they become catatonic [“locked”], stops performing. It’s important to prepare them for what
will happen during the lesson. They think a lot faster than us, so to keep them prepared is good.

I: What methods do you use to cope with, or mitigate, these traits?

R: Prepare them for all assignments, clear frameworks, clear instructions, and what is expected by them. I need to make instructions more concrete.
Appendix B - Survey responses.

Responses are listed below, to illustrate calculations, as well as how prevalent each rank is in each answer respectively.

Abnormal sensitivity to positive and negative reinforcement:
\[(2+3*3+4+5*5+6*5)/15=70/15= 4.6\]
\[AR=4.6\]

Aggression:
\[(1+3*2+4*2+5*4+6*6)/15=71/15= 4.7\]
\[AR=4.7\]

Benefit from computer assisted instructions:
\[(2+3*3+4*5+5*3+6*3)/15=64/15= 4.2\]
\[AR=4.2\]

Blurs out answers and communications:
\[(1+2+4+5*6+6*6)/15=73/15= 4.8\]
\[AR=4.8\]

Cannot wait their turn:
\[(1*2+4*4+5*4+6*5)/15=68/15= 4.5\]
\[AR=4.5\]

Clumsiness:
\[(1*2+2*4+3*3+4*3+5*2+6)/15=47/15= 3.1\]
\[AR=3.1\]

Communication problems:
\[(1+2+3*5+4*3+5*4+6)/15=56/15= 3.7\]
\[AR=3.7\]

Difficulties being still/calm, fidgety:
\[(3*2+5*7+6*6)/15=77/15= 5.1\]
\[AR=5.1\]

Difficulties following instructions:
\[(1+3+4*3+5*8+6*2)/15= 68/15= 4.5\]
\[AR=4.5\]

Difficulties with social interactions:
\[(1+2+3*2+4*5+5*2+6*4)/15=63/15= 4.2\]
\[AR=4.2\]

Difficulty initiating:
\[(1+2*5+3*2+4*5+5*2)/15=47/15= 3.1\]
\[AR=3.1\]
Disorganized:
\[(3^2+4^3+5^6+6^4)/15=72/15=4.8\]
AR=4.8

Disruptive behaviour/ loud & noisy:
\[(1^2+3^4+4^5+6^3)/15=61/15=4.0\]
AR=4.0

Easily distracted:
\[(3+4^2+5^2+6^10)/15=81/15=5.4\]
AR=5.4

Easily overwhelmed:
\[(1+3^5+4^5+5^2+6^2)/15=58/15=3.8\]
AR=3.8

Excels at practical subjects:
\[(1+2+3^4+4^2+5^4+6^3)/15=61/15=4.0\]
AR=4.0

Forgetful:
\[(1^2+2^3+2+4^6+5^2+6^2)/15=56/15=3.7\]
AR=3.7

Goof off when trying new things:
\[(1^2+2^2+4^5+8^6+2^)/15=62/15=4.1\]
AR=4.1

Hard time keeping/ maintaining focus:
\[(2+4^5+8^6)/15=76/15=5.0\]
AR=5.0

Hard time visualizing goals:
\[(1+3+4^3+5^6+6^4)/15=70/15=4.6\]
AR=4.6

Hyperactivity:
\[(2+3^2+5^3+6+6^3)/15=68/15=4.5\]
AR=4.5

Impulsivity:
\[(1+4^4+5^5+6^5)/15=72/15=4.8\]
AR=4.8

Immature language:
\[(1^2+2^3+3^2+4^5+5^2+6)/15=50/15=3.3\]
AR=3.3

Impatient:
\[(1+2+4^3+5^6+6^4)/15=69/15=4.6\]
AR=4.6
Inattentive:
\[(1^2+2+3+4^7+5^3+6)/15=56/15=3.7\]
AR=3.7

Interruptive:
\[(1+4^*4+5^5+6^5)/15=72/15=4.8\]
AR=4.8

Low attention to details:
\[(1+2^*3+4^4+4^5+5^2)/15=49/15=3.2\]
AR=3.2

Low time management skill:
\[(1+3^2+4^1+5^8+6^3)/15=69/15=4.6\]
AR=4.6

Lower grades/academic performance than their peers:
\[(1^2+3^6+4^3+5^3+6)/15=53/15=3.5\]
AR=3.5

Mood swings:
\[(3^2+4^5+5^5+6^3)/15=69/15=4.6\]
AR=4.6

Motivated by rewards:
\[(2^2+3^3+4^5+5^3+6^2)/15=60/15=4.0\]
AR=4.0

Need for structure:
\[(4+5+6*13)/15=87/15=5.8\]
AR=5.8

Non-compliant:
\[(1^2+2+3^4+4^4+5^3+6)/15=53/15=3.5\]
AR=3.5

Short attention span:
\[(3^2+4^3+5^6+6^4)/15=72/15=4.8\]
AR=4.8

Rarely asks for help:
\[(1+2^3+3^5+4^3+5^3)/15=49/15=3.2\]
AR=3.2

Work better with subtasks:
\[(5^6+6^9)/15=84/15=5.6\]
AR=5.6